CLAIMS

1.   A method for processing sound signals for hearing impaired persons, said method comprising:

        (a) filtering a sound signal to obtain channel signals for at least two channels;

        (b) determining an estimated signal level for each of the channel signals;

        (c) determining an initial gain amount for each of the channel signals;

        (d) constraining the initial gain amount for each of the channel signals against gain amounts associated with at least one neighboring channel based on the corresponding estimated signal levels; and

        (e) amplifying the channel signal in accordance with the corresponding constrained initial gain amount.

2.   A method as recited in claim 1, wherein said constraining (d) comprises:

        (d1) comparing the estimated signal level to at least one threshold level to obtain comparison information; and

        (d2) constraining the initial gain amount for the channel signal against at least one gain amount associated with at least one neighboring channel based on the comparison information.

3.   A method as recited in claim 1, wherein the channel signal pertains to a frequency band, and

        wherein said method further comprises:

        (f) combining the amplified channel signal with other amplified channel signals from other frequency bands of the sound signal.

4.   A method as recited in claim 3, wherein said constraining (d) comprises:

(d1) comparing the estimated signal level to at least one threshold level to obtain comparison information; and

(d2) constraining the initial gain amount for the channel signal against the gain amount associated with at least one neighboring channel based on the comparison information.

5.   A method as recited in claim 1, wherein said constraining (d) operates to average the initial gain amount for the channel signal with at least one other gain amount associated with a neighboring channel.

6.   A method as recited in claim 5, wherein the average operation is weighted average.

7.   A method as recited in claim 5, wherein the neighboring channel is a channel adjacent to the channel.

8.   A method as recited in claim 5, wherein the neighboring channel pertains to a lower frequency band that is adjacent to the frequency band for the channel.

9.   A method as recited in claim 1, wherein said constraining (d) operates to average the initial gain amount for the channel signal with a plurality of other gain amounts associated with neighboring channels.

10.   A method as recited in claim 9, wherein the average operation is weighted average.

11.   A method as recited in claim 9, wherein the neighboring channels are
5   channels adjacent to the channel.

12.   A method as recited in claim 11, wherein the neighboring channels include at least one channel at a lower frequency band that is proximate to the frequency band for the channel, and at least one channel at a higher
10   frequency band that is proximate to the frequency band of the channel.

13.   A method for amplifying sound signals in a multi-band sound processing system, said method comprising:

       receiving a signal level estimate for a channel signal corresponding to
15   a particular frequency band of a sound signal; and

       determining a suitable gain amount for the channel signal based on the signal level estimate,

       wherein, when the signal level estimate has a high level, the suitable gain amount is constrained to preserve spectrum contrast across frequency
20   bands, thereby preserving speech clarity and intelligibility.

14.   A method as recited in claim 13, wherein said determining comprises:

       comparing the signal level estimate for the channel signal to a first threshold amount; and

25   constraining the suitable gain amount for the channel signal when said comparing determines that the signal level estimate exceeds the first threshold amount.

15.   A method as recited in claim 13, wherein said determining comprises:

producing an initial gain amount for the channel signal;

comparing the signal level estimate for the channel signal to a first threshold amount;

producing the suitable gain amount as the initial gain amount when said comparing determines that the signal level estimate is less than the first threshold amount; and

constraining the initial gain amount and then producing the suitable gain amount as the constrained initial gain amount when said comparing determines that the signal level estimate is greater than the first threshold amount.

16.   A method as recited in claim 15, wherein said constraining operates to average the initial gain amount for the channel signal with at least one other gain amount associated with a neighboring channel.

17.   A method as recited in claim 16, wherein the average operation is weighted average.

18.   A method as recited in claim 16, wherein the neighboring channel is a channel adjacent to the channel.

19.   A method as recited in claim 13, wherein said determining comprises:

producing an initial gain amount for the channel signal;

comparing the signal level estimate for the channel signal to a first threshold amount and a second threshold amount;

producing the suitable gain amount as the initial gain amount when said comparing determines that the signal level estimate is less than the first threshold amount;

constraining the initial gain amount to a first extent and then producing the suitable gain amount as a first constrained initial gain amount when said comparing determines that the signal level estimate is greater than the first threshold amount and less than the second threshold amount; and

constraining the initial gain amount to a second extent and then producing the suitable gain amount as a second constrained initial gain amount when said comparing determines that the signal level estimate is greater than the second threshold amount, the constraining to second extent being more constraining than constraining to the first extent.

20. A method as recited in claim 19, wherein said constraining operates to average the initial gain amount for the channel signal with at least one other gain amount associated with a neighboring channel.

21. A method as recited in claim 20, wherein the average operation is weighted average.

22. A method as recited in claim 19,

wherein said constraining to the first extent operates to average the initial gain amount for the channel signal with at least one other gain amount associated with a neighboring channel, and

wherein said constraining to the second extent operates to average the initial gain amount for the channel signal with a plurality of other gain amounts associated with neighboring channels, the number of other gain amounts being greater by at least one more than that used with said constraining to the first extent.

23.   A method as recited in claim 22, wherein the average operation is weighted average.

5   24.   A method for amplifying sound signals in a multi-band sound processing system, said method comprising:

receiving a signal level estimate for a channel signal corresponding to a particular frequency band of a sound signal; and

determining a suitable gain amount for the channel signal based on the signal level estimate,

wherein, when the signal level estimate has a high level, the suitable gain is constrained to limit variation of gain difference across frequency bands, thereby preserving speech clarity and intelligibility.

15   25.   A method as recited in claim 24, wherein said method further comprises:

filtering a sound signal to obtain a plurality of channel signals, including the channel signal.

20   26.   A system for processing sound signals for hearing impaired persons, said system comprising:

a microphone to convert a sound pressure signal into an electronic sound signal;

a signal processing unit operatively connected to said microphone,

25   said signal processing unit operates to filter the electronic sound signal to obtain channel signals for at least two channels, determine an estimated signal level for each of the channel signals, determine an initial gain amount for each of the channel signals based on the estimated signal level, constrain the initial gain amounts for the channel signals by combining the initial gain

amount with other gain amounts associated with neighboring channels to produce constrained gain amounts amplify the channel signals in accordance with the constrained initial gain amounts, and combine the amplified channel signal into a processed electronic sound signal; and

5   a receiver to convert the processed electronic sound signal to a sound pressure signal.

27.   A system as recited in claim 26, wherein said signal processing unit is a digital signal processor.

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28.   A system for amplifying sound signals in a multi-band sound processing system, said system comprising:

       a microphone to convert a sound pressure signal into an electronic sound signal; and

15   a signal processing unit operatively connected to said microphone, said signal processing unit operates to filter the electronic sound signal to obtain channel signals for at least two channels with different frequency bands, receive a signal level estimate for each of the channel signals, and determine a suitable gain amount for each of the channel signals based on

20   the signal level estimate corresponding to each of the channel signals,

       wherein, when the signal level estimate has a high level, the suitable gain is constrained to preserve spectrum contrast across frequency bands.

29.   A system for amplifying sound signals in a multi-band sound
25   processing system, said system comprising:

       a microphone to convert a sound pressure signal into an electronic sound signal; and

       a signal processing unit operatively connected to said microphone, said signal processing unit operates to filter the electronic sound signal to

obtain channel signals for at least two channels with different frequency bands, receive a signal level estimate for each of the channel signals, and determine a suitable gain amount for each of the channel signals based on the signal level estimate corresponding to each of the channel signals,

5   wherein, when the signal level estimate has a high level, the suitable gain amount is constrained to limit variation of gain difference across frequency bands.

30.   A hearing aid device, comprising:

        a microphone for picking up a sound signal;

        signal processing circuitry operatively connected to said microphone, said signal processing circuitry operating to process the sound signal to produce a modified sound signal; and

        an output device that produces an output sound in accordance with the
15   modified sound signal,

        wherein said signal processing circuitry operates to filter the sound signal into a plurality of channel signals of different frequency bands, obtain signal level estimates for each of the channel signals, and determine suitable gain amounts for the channel signals based on the signal level estimates, and

20   wherein, in determining each of the suitable gain amounts, when the signal level estimate has a high level, the corresponding suitable gain amount is constrained against gain amounts associated with one or more other channel signals.

25   31.   A hearing aid device as recited in claim 30, wherein the constraining of one or more of the suitable gain amounts serves to preserve spectrum contrast across frequency bands, thereby preserving speech clarity and intelligibility.

32.   A hearing aid device as recited in claim 30, wherein the constraining of one or more of the suitable gain amounts serves to limit the variation of gain difference across frequency bands, thereby preserving speech clarity and intelligibility.

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33.   A computer readable medium including at least computer program code for processing sound signals, said computer readable medium comprising:

        computer program code for filtering a sound signal to obtain a channel
10   signal for a channel;

        computer program code for determining an estimated signal level for the channel signal;

        computer program code for determining an initial gain amount for the channel signal based on the estimated signal level;

15   computer program code for constraining the initial gain amount based on the estimated signal level; and

        computer program code for amplifying the channel signal in accordance with the constrained initial gain amount.

20 34.   A computer readable medium as recited in claim 33, wherein said computer program code for constraining comprises:

        computer program code for comparing the estimated signal level to at least one threshold level to obtain comparison information; and

        computer program code for constraining the initial gain amount for the
25   channel signal against a gain amount associated with at least one neighboring channel based on the comparison information.

35.   A computer readable medium as recited in claim 33, wherein the channel signal pertains to a frequency band, and

wherein said computer readable medium further comprises:

computer program code for combining the amplified channel signal with other amplified channel signals from other frequency bands of the sound signal.